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LAND USE CHANGES OF THREE DECADES IN THE VELENCE MOUNTAINS, HUNGARY

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Introduction

62000 km^2 of Hungary's 93000 km^2-area is under agricultural cultivation and it is decreasing continuously since 1990. Now it is smaller with 4000 km^2 than 10 years ago. More than 48000 km^2 are arable land and 17000 km^2 are forest. The vineyard and orchard are 5 % of the cultivated area.[1] The ratio of the forest is less than 19 % (the average ratio in the European Union is 40 %). There were two forestations in the country in the 20th century. The first started after World War II and it increased the area of forest with 7000 km^2. Another, similar period started in 1991 and 1.500 km^2 area was planned to be forest until 2000. The pecuniary resources were enough to put through the forestation on the less than half of the planned area, on only 600 km^2[2]

Our study area – the first order watershed of the Lake Velence – was a part of these changes and we wanted to investigate the attributes of this transformation.

The Velence Mountains and its surroundings

The Velence Mountains occupies about 80 km^2 in the middle of Hungary with the highest peak Meleg-hegy, which stands 351 meters above sea level. It is a strongly denuded and fragmented Carboniferous granite pluton partly covered with old schist and very young loess. There is a depression on the hillfoot area that contains the 9000-year-old and 1.5-meter-deep Lake Velence with 236 km^2 of watershed area (*Ádám, 1988*).

In the 60's and early 70's, natural values of the area were the lake itself, the relatively intact and hilly landscape and the very temperate climate beside the vicinity of Budapest. It started to be transformed into a strongly used agricultural landscape with cultivation, vineyards and forestry and an increasing rate of weekend and seasonal tourism. The changes of the land use have been severe and easily observable even until nowadays in the 48 - km^2 - broad first order watershed of the lake. It is the southern slope of the Mountains and it takes four villages: Pákozd, Sukoró, Nadap and Velence.

Aims and methods

We were searching for the answers to the next four questions:

[1] Source: Napi Gazdaság, 4. September 2000. Ellentmondásos folyamatok az agrárágazatban

[2] Source: Napi Gazdaság, 4. September 2000. Lassan megtérülő befektetés az erdővásárlás

A) Where did any changes occur?
B) If there were some changes, than from what to what?
C) Are there changes in relation to other physical geographical parameters?
D) Can we recognize any trend in the changes?

We used the tools of Geographical Information Systems (GIS) to compare the land use maps during three time periods, 1968, 1986-87 and 1999.

Sources

The base-maps were the topographical maps in the scale of 1:10000, which set the conditions of the 1986-87 years. The projection system of the maps is the Uniform National Projection System (EOV), a special Hungarian projection. The co-ordinates were given in kilometres. The first order watershed of the Lake Velence is 48 km^2 and 8 maps cover it. The Digital Elevation Model (DEM) was generated from the contour lines and stressed elevation points of the maps. The DEM includes the 4-8 km wide surroundings of the investigated watershed, covering totally the area of the Velence Mountains as well.

We have created the land use map of the 60's using the military maps in the scale of 1:25000, which were published in 1968 in stereographic projection system. The digital version of the soil map is originated from maps containing soil types, subtypes and soil texture categories. The original maps were created for agricultural purposes, so there is not any information about the soils under forests and built-up areas. The map scale was 1:25000.

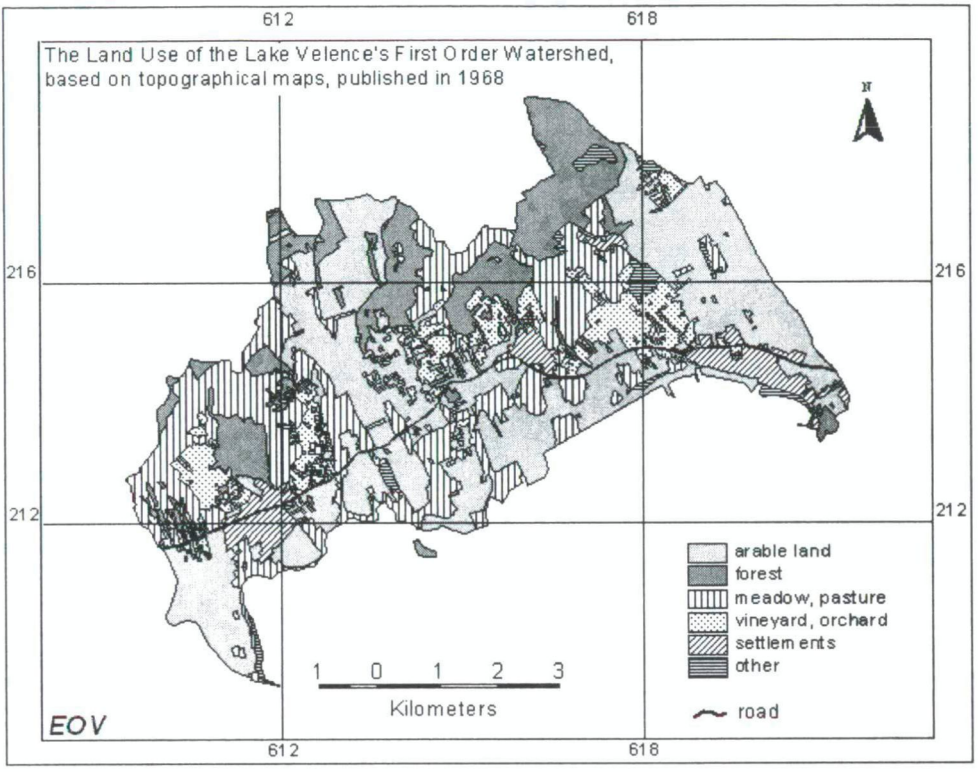
Digital maps

Land use

Based on the topographical- and the military maps we were able to catch the land use changes of the last 32 years for three time periods. The borders of the cultivation were digitized manually from the maps published in 1968 and 1986-87, then the closed areas were labelled according to the categories of the land use. The prepared digital maps were suitable to build polygon topology and to create the land use maps. The characteristics of the land use status in 1999 were mapped during a fieldtrip together with geography students, then this map was also digitized manually. The *Map 1* shows the starting situation in 1968 and the land use from 1999 can be seen on *Map 2*.

The details of the land use categories were different in each case. We could separate vineyards, orchards and vineyards with orchards on the map from 1968 and 1999, while the map from 1986 allowed of the separation into two categories, the vineyards and the orchards. There was no any map that would have contained the type of the arable lands, but we could map this important information during the fieldwork too, so the map from 1999 shows three categories of arable lands. The separation of the cereals, hoed-plants and fodder-plants was interesting because of soil erosion and other hazards. The fact with the forests is similar: there were only two categories separated in 1968, while the other two maps from 1986 and 1999 contained already five types of forests.

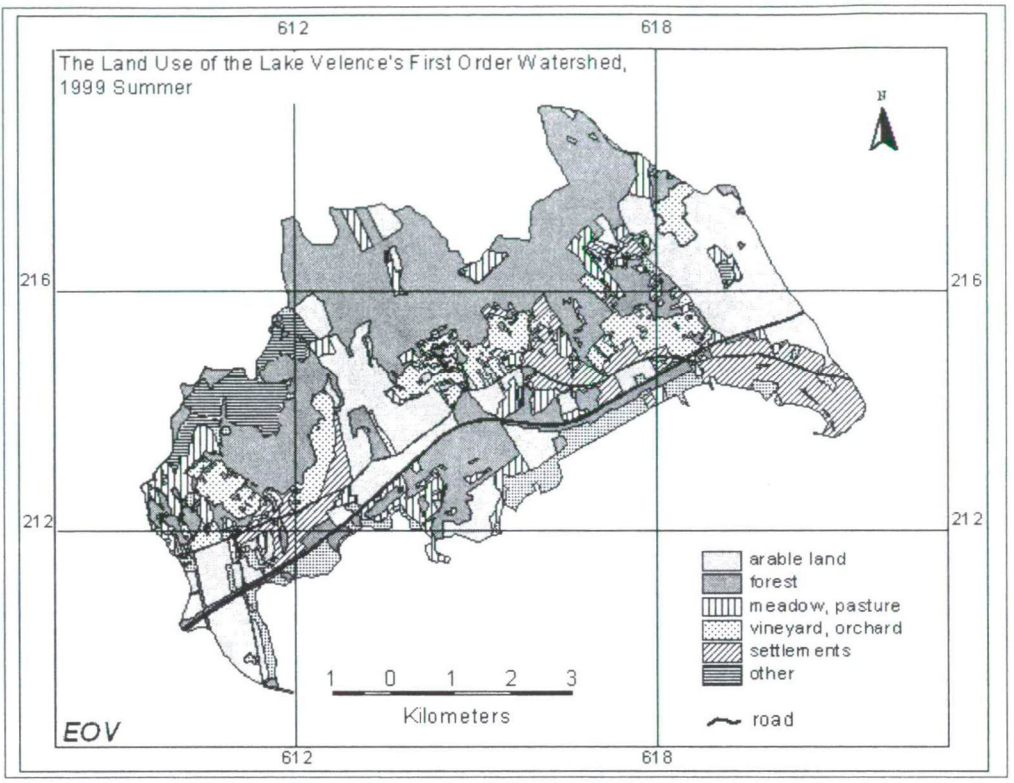
We have used unified categories that were typical of all the three maps to compare the land use from the three time periods. These wider categories were also ordered for the polygons as attribute data.



Map 1 Land use in 1968

Soils

The agricultural soil map in the scale of 1:25000 shows the soils of the mountains and their surroundings, including 5 soil texture categories, 7 soil types and 29 subtypes. We have digitized the patches and rectified them into the EOV system based on control points due to the lack of the co-ordinates on the map. The characteristic codes of the soil patches were stored as attributes, ordered to the polygons. The polygon operators used in the geoinformatical systems allowed us to merge the patches with the same parameters. As a result of this method, we got a clearly arranged digital map, which is easier to use than the original paper map.



Map 2 Land use in 1999

Elevation

We digitized the main and mid contour lines from 12 topographical maps to create the Digital Elevation Model (DEM) for the Velence Mountains. We generated the DEM using algorithm of the TOPOGRID module within Arc/Info. The size of the cell is 10 m. The elevation data of the lakes and reservoirs was replaced by their elevation above the see level. Using these procedures and algorithms of the Arc/Info we have got a hydrologically correct elevation model. We derived the aspects and the slopes (*Table 1*) as the first characteristics of the surface, because we wanted to see the connection between the land use changes and them. The DEM will also be used in our further investigations (soil erosion, landscape household, morphometry).

Steepness	**Area (Ratio of area of the Mountains)**
0 – 2 degrees	43.1 km^2 (35.5 %)
2 – 5 degrees	38.6 km^2 (31.6 %)
5 – 10 degrees	27.7 km^2 (22.8 %)
above 10 degrees	12.3 km^2 (10.1 %)

Table 1 Slope categories of the Velence Mountains

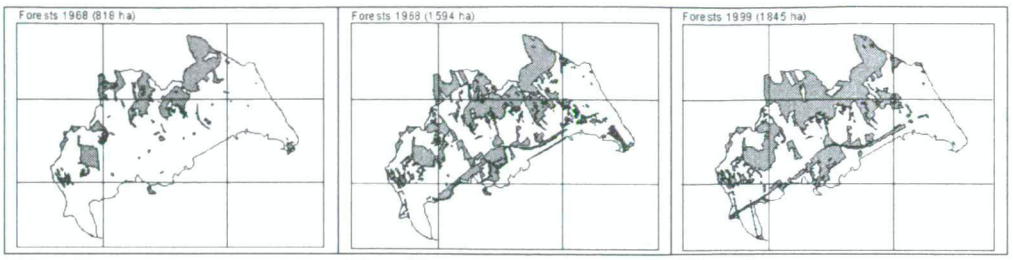
Detection of changes by overlapping

We can follow the structural changes in the land use if we see the aggregated area of the given land use categories between the three time periods *(Table 2).* We have to take the different origin and scale of the maps into consideration if we analyse the changes. The data of 1968 came from a military map in the scale of 1:25000, the original map of 1986 is the topographical map in the scale of 1:10000 (both were edited by cartographers), while the land use map from 1999 was mapped by geography students during a fieldtrip. For instance, the surrounding area of the villages with gardens, small vineyards and houses were mapped as „built-up area". This generalisation should have taken part in the very strong expansion of the built-up areas in 1999 while the houses and gardens are separated on the other maps.

Land use categories	**Total area (ha)**			**Changes (ha)**		
	1968	**1986**	**1999**	**1968-86**	**1986-99**	**1968-99**
built-up area	295.56	353.68	572.52	58.12	218.84	276.96
vineyard, orchard	509.46	430.29	498.90	-79.17	68.61	-10.56
arable land	1963.04	1329.84	1104.58	-633.20	-225.26	-858.46
meadows and pastures	1189.48	504.30	400.69	-685.18	-103.61	-788.79
forests	818.88	1594.65	1845.82	775.77	251.17	1026.94
natural	55.25	474.61	193.18	419.36	-281.43	137.93
wetland	16.68	170.67	208.48	153.99	37.81	191.80
abandoned area	22.50	12.82	46.68	-9.68	33.86	24.18
	4870.85	**4870.85**	**4870.85**	**48,50 %**	**28,42 %**	**51,44 %**

Table 2 The aggregated areas of land use categories and the changes in their area between the three time periods in hectare and the ratio of the total changed area compared to the watershed

The aggregated area of vineyards and orchards have decreased until the late 80's and increased again after the political changes and the compensation and privatisation of land in the 90's. This increasing has not reached the earlier value yet. The significant decreasing of the total area of meadows and pastures and the increasing of the area covered by natural vegetation should have come from the confused and undefined categories of the maps. For instance, the whole natural vegetation in 1986 was pasture on the western side of the watershed on the map from 1968. The area was for military purposes and it was not permitted to be shown even on a military map. This problem with the categories will be solved, because it is a planned protected area. The growth in the forest area is clear (*Map 3a, 3b, 3c.*). The decline of the area of arable lands and pastures means that the economy became more intensive but most of the „new" fields were turned into forest rather than vineyards or orchards.

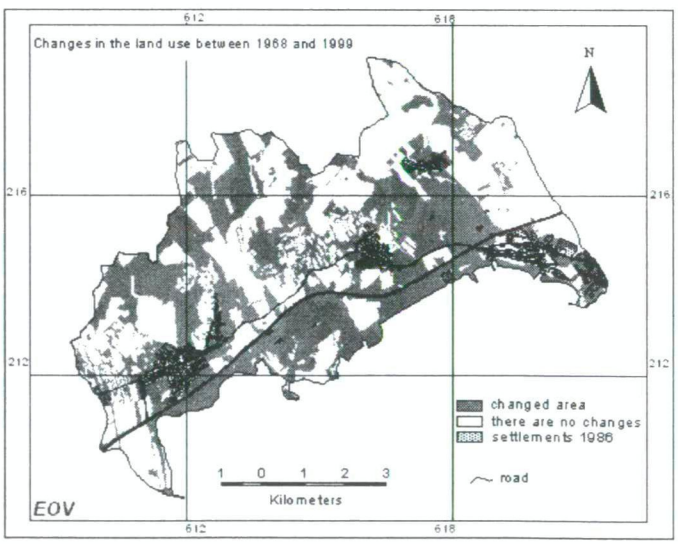


Map 3a **Map 3b** **Map 3c**

Results

A) Where did any changes occur?

Our analyses are based on grids that we got after the rasterization of polygon maps. The used cell size was 5 m. The cells always inherited the values of the wider, common categories from the polygons. Working with the GIS operations and functions (*GIS by ESRI, 1994*) we were able to identify the changed area and retrieve the changes. *Map 4* shows the changed areas between 1968 and 1999 and *Table 1* contains the ratios of the total changed area compared to the watershed during the three time periods.



Map 4 Changes of the land use between 1968 and 1999

B) *Retrieving the changes*

The investigation of the changed categories was taken by using the exponential function and the place value of the binary system. The algebraic connections of the given values allowed to explore the way of the changes. We have produced a map with using categories of aggregated areas larger than 15 hectares. *Table 3* shows the data used for the map.

1986	1999	Σ Area	Ratio (ws)	Ratio (chd)
arable land	forest	143,2 ha	3,02 %	10,63 %
arable land	vineyard, orchard	109,2 ha	2,30 %	8,10 %
arable land	meadow and pasture	94,69 ha	2 %	2,79 %
Forest	vineyard, orchard	24,4 ha	0,51 %	1,81 %
Forest	arable land	29,2 ha	0,62 %	2,16 %
Forest	meadow and pasture	38,0 ha	0,80 %	2,82 %
Meadow and pasture	vineyard, orchard	34,0 ha	0,71 %	2,52 %
Meadow and pasture	forest	157,8 ha	3,33 %	11,71 %
Meadow and pasture	arable land	45,15 ha	0,95 %	1,33 %
Vineyard, orchard	arable land	17,24 ha	0,36 %	0,5 %
Vineyard, orchard	meadow and pasture	14,88 ha	0,31 %	0,44 %
		707,76 ha	**14.94 %**	**15,88 %**

Table 3 Changes with their aggregated areas and their ratio compared to the watershed (ws) and the total area of changes (chd) (1986 – 1999)

The above mentioned cross-tabulation was completed between the maps from each time period.

C) Are the changes in relation to other physical geographical parameters?

The watershed has a not too intensive relative relief, the changed areas are seemingly independent of elevation and the steepness. The highest and steepest areas were covered by forest earlier and even later. We compared the changed area with the aspect of slopes and the fact was not surprising that most of the changes happened to be on the south-facing slopes, because 65 % of the watershed can be characterized having south-facing slopes and only 11 % with north-facing. Most of the changes took place on sandy loam and loam soils, but the investigated watershed is covered by this kind of soil more than 70 %.

D) Can we recognize any trend in the changes?

Comparing all the changes in our area, we can declare that the forestation was the most significant change during the last 32 years (*Table 2*). The other changes followed the general trends, so the area of the arable lands decreased parallel to the increasing intensity of agriculture. The vineyards and orchards were in decline, but they have been revived since the political changes. The motivation for the changes were pure economical considerations.

Conclusions

Comparing the status of land use in the three above mentioned time periods, we can conclude that the most significant process in the watershed was the afforestation. It happened mainly at the cost of arable lands, meadows and pastures (*Table 2*). The changes in the area of vineyards and orchards are not considerable, but there was some decrease until the end of the 80's.

There was no any physical geographical phenomenon, which one can consider to be responsible for any changes. We suppose that there was only a socio-economical background for the changes. Since the changes have a strong effect on the natural environment we are able to analyse them using the detailed digital land use maps.

References

ÁDÁM L. (1988) **A Velencei-hegység és környéke** – in: *Ádám L. – Marosi S. – Szilárd J.* (szerk.): A Dunántúli-középhegység regionális földrajza B). Magyarország tájföldrajza 6. Akadémiai Kiadó, Budapest, pp. 235-246.

GIS by ESRI (1994) **GRID Commands** – Redlands, CA, USA

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